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BIOLOGICAL
EVALUATION R10-81-1

SPRUCE BEETLE

CHUGACH NATIONAL FOREST
and
ADJACENT LANDS

JANUARY 1981

U.S. Department of Agriculture
State and Private Forestry

Forest Service
Alaska Region

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CHUGACH NATIONAL FOREST and ADJACENT LANDS

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Prepared By: Edward H. Holsten

Edward H. Holsten, Entomologist
Forest Pest Management
Region 10, Alaska

Approved By: Robert D Averill

Robert D. Averill, Group Leader
Forest Pest Management
State and Private Forestry
Region 10, Alaska

Marvin C. Meier, Director
State and Private Forestry
Region 10, Alaska

Forest Pest Management
State and Private Forestry
USDA Forest Service, R-10
2221 E. Northern Lights Blvd.
Suite 107
Anchorage, Alaska 99504

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INTRODUCTION

Alaskan spruce beetle (Dendroctonus rufipennis (Kby.))(App.D) populations are high throughout south-central Alaska; approximately 345,940 acres of infested white spruce (Picea glauca (Moench)Voss.) were aerially detected in 1980. White spruce mortality is occurring on 32,200 acres of the Chugach National Forest. This represents an increase of 1085 acres (3 percent) over 1979 levels.

Specifically, the Summit Lake infestation has increased for the third consecutive year. Aerial surveys detected 13,546 acres of infested spruce; a significant increase of 52 percent over 1979 levels. The Resurrection Creek infestation has not expanded from the 1979 level of 14,826 acres. However, the number of killed trees and new attacks are increasing. To date, 7,093 board feet per acre of white spruce has been killed by the beetle in five years. This represents almost 60 percent of the commercial size white spruce volume in the area.

A 1979 Forest Pest Management report (Holsten 1979) indicated that spruce stands along the Indian Creek drainages and near Hope had a high probability of becomming infested. The risk rating system (Holsten and Wolfe 1979) classified these stands (four in the Indian Creek drainages and one near Hope) as high risks. 1980 aerial surveys detected active beetle populations in these areas. The stands near Hope are becomming infested as a result of a northerly movement of the Resurrection Creek infestation. The stands located in both Big and Little Indian drainages are in close proximity to a large spruce beetle outbreak (Barabara Lake), a few miles to the west. There is a good possibility that immigrating beetles from this area initiated the flare-up in the Indian Creek drainages.

Elsewhere on the Chugach National Forest infestations are static or, in some localities, just beginning. Beetle activity is still apparent in the following areas: Cooper Landing, Snug Harbor, Cooper Lake road, and Silvertip. Light beetle activity was detected in the Russian River campground (Fig. 1).

Approximately 45,227 acres of infested spruce were aerially detected on the Kenai National Moose Range in 1980. The Barabara Lake infestation is increasing and now encompasses close to 11,831 acres. Approximately 1,000 acres are infested around the Skilak Lake campgrounds; another 18,916 acres are infested due west of Tustemena Lake. Near Homer, infestations cover approximately 4,117 acres.

OBJECTIVES

If the spruce beetle outbreaks are allowed to run their natural cycles, significant changes in stocking levels and aesthetic qualities of the landscape will occur. Accordingly, it was decided that Biological Evaluations should be undertaken in the Chugach Natinal Forest and adjacent lands to provide management wuth up-date information concerning forest pest conditions.

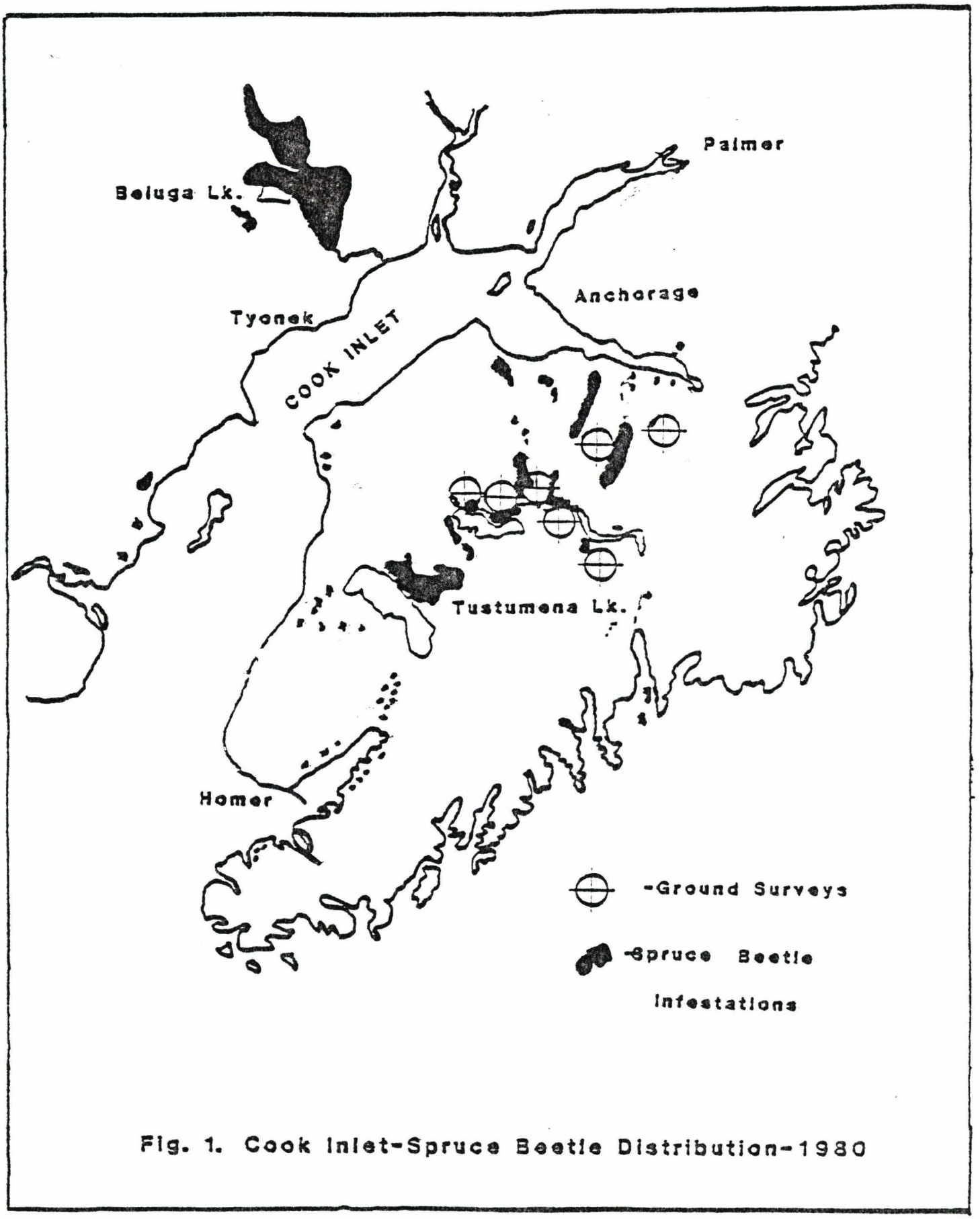

Fig. 1. Cook Inlet-Spruce Beetle Distribution-1980

MATERIALS AND METHODS

STUDY SITES:Ground surveys were conducted in August and September (1980) by F.P.M. personnel in the following areas:

Russian River: Ten plots were established along the lower Russian Lake trail; beginning approximately one mile from the trail-head.

Snug Harbor: Ten plots were established on the south side of the Snug Harbor road, approximately one mile from the Kenai Lake bridge.

Cooper Lake Road: Ten plots were established two miles southwest of the power plant, along the Cooper Lake road.

Summit Lake: Due to the increasing beetle activity in the Summit Lake area, another condensed evaluation was carried out in 1980 northwest of Upper Summit Lake, north of the gravel pit. Complete and condensed biological evaluations were done in 1978 and 1979 (Averill 1978, Holsten and Zogas 1979).

Silvertip Creek: Ten plots were established southwest of the Seward Highway at Milepost 61.

Skilak Lake Campgrounds: Bark beetles have been active in two campgrounds for at least three years. Even though these campgrounds are located within the Kenai National Moose Range, an evaluation was undertaken to gain more base-line data. Ten and five plots were established in the upper and lower campgrounds, respectively.

STAND COMPOSITION:Variable plots (BAF=10) were established in each area with the exception of Summit Lake; stand composition was previously documented by Averill (1978). Plots were established at five chain intervals on lines five chains apart throughout the stand. A basal area 10-factor prism and a Spiegal Relaskop were used to determine plot trees and tree heights. All trees within each plot were recorded by species and diameter at breast height(d.b.h.). Radial growth and height were determined for two dominant or co-dominant spruce trees in each plot.

SPRUCE BEETLE POPULATIONS: When spruce beetle infestation centers were encountered, two 6x6 inch bark samples (north and south side) were removed from infested trees at d.b.h. Trees selected for sampling were attacked in the Spring of **1979**. These trees contained new adults which will form the 1981 attacking population. The number of adults per bark sample was recorded along with the number and type of parasites and amount of woodpecker activity. Results were compared with Knight's (1960) sequential sampling plan for spruce beetles to give an indication of population trends.

RESULTS AND DISCUSSION[1/]

RUSSIAN RIVER

Stand Composition: The surveyed stand contained 84.3 percent white spruce, 13.3 percent western hemlock (Tsuga heterophylla(Raf.)Sarg.), a 2 percent paper birch (Betula papyrifera Marsh.). Mean d.b.h. for the species are: spruce 12.4 ± 3.9", hemlock 9.2 ± 3.4", and birch 10.6 ± 1.6". Mean height and age for the spruce are 86.6 ± 17.7' and 209 years, respectively.

Mean basal area for plots containing spruce is 138 ± 14.4 square feet per acre. Basal area ranged from 70 to 190 square feet. The mean outer inch of spruce radial growth is 10.1 rings per inch. Thus, spruce diameter growth is averaging .05 inches per year in the last inch of growth. Mean volume of commercial white spruce is approximately 15,954 b.f. per acre[2/].

Spruce Beetle Populations and Tree Mortality: Twenty bark samples were removed; only two samples contained adult beetles. A total of four spruce beetles were counted indicating a decreasing population (Knight 1960). Only one tree had signs of woodpecker activity.

Mean diameters of recently attacked and old-attack dead white spruce were 14.6 ± 4.4" (n=12) and 13.6 ± 2.4 (n=9), respectively. Diameters of old attack (dead) white spruce are not significantly greater (Students "T", .05) than recently attacked trees.

Average commercial white spruce volume of the infested area is 15,954 b.f. per acre. Of this volume, 7 percent (1,055 b.f./ac.) is standing beetle killed timber. An additional 10 percent (1,553 b.f./ac.) of the commercial timber is beetle attacked and may die.

The Russian River stand is characterized by large diameter spruce and a very high commercial volume per acre. Although there is some beetle activity in the area, the beetle population trend is decreasing. That is to say, fewer trees will be attacked in 1981. The beetle activity in standing trees most likely originated from the prevalent blowdown in the area, especially along the slopes facing the Russian River.

Assuming a $20/MBF strumpage value[3/] for white spruce on the Kenai Peninsula, the monetary loss from the present 100 acre spruce beetle infestation is $5,216. This is assuming that the currently infested trees will die.

1/See Appendices A,B, and C for Summary

2/Volume estimates were derived from:(1)R-10 Volume Tables for Alaska White Spruce, For. Serv. Hndbk. 2425, Jan. 1967 in conjunction with (2)Table 1(Stand Factors)from "Log Scaling and Timber Cruising", 1966. J.R. Dilworth. O.S.U. Bookstore. pg. 263.

3/Bob Green. Dec. 1980. Silviculturist. Chugach Nat'l. Forest. Personal Communication, Anchorage, Ak.

SNUG HARBOR:

Stand Composition: The steep Snug Harbor stand is composed of white spruce interspersed with birch, hemlock, and alder (Alnus spp.). Scattered blowdown occurs throughout the area. Mean diameters for the species are: white spruce 11.4 ± 3.6" (91%), hemlock 9.8 ± 4.5" (5%), and birch 13.6 ± 4.6" (3%). Mean height and age for spruce are 65.5 ± 13.4' (n=36) and 192.5 ± 22.6 years (n=18), respectively.

Mean basal area for the plots containing white spruce is 101.1 ± 15.7 square feet per acre, ranging from 30 to 160 square feet. The mean outer inch of radial growth is 41.8 ± 21 rings per inch; spruce diameter growth is averaging .05 inches per year in the last inch of growth. Mean commercial volume for plots containing spruce is 6,578 b.f. per acre.

Spruce Beetle Population and Tree Mortality: Fifty bark samples (64 % infested) were removed yielding a total of 131 adult spruce beetles; mean adult density per sample was 2.6 beetles. These numbers indicate a static beetle population (Knight 1960). Signs of woodpecker activity were apparent on most trees.

Mean diameter of recently attacked and old attacked (dead) white spruce are 12.1 ± 3.4" and 12.4 ± 3.3", respectively. Of the commercial white spruce volume, 35 percent (2,311 b.f./ac.) is standing beetle killed timber. Another 38 percent (2,476 b.f./ac.) is under attack; many of these trees will die. Twenty-seven percent of the commercial white spruce volume is free of attack.

Beetle populations are static in the Snug Harbor study area. The beetles will continue to attack spruce in 1981 equal to the amounts attacked in 1980. This trend will probably continue for at least two years as the mean diameter of recently attacked spruce is significantly higher than mean spruce diameter of the stand. Thus, the beetles still have ample (large diameter) food supplies. Total monetary loss for the 724 acre infestation, assuming the recently attacked spruce will die, amounts to $69,315. An annual loss of $35,852 is expected for the infested area based on a static population.

This infestation probably originated from two sources: (1)beetles immigrating from the Cooper Landing infestation (Holsten and Zogas 1979) directly across the Kenai River, and (2)from the prevalent blowdown occurring in the infested area. Woodpecker activity was common in the area. This, in part, may help maintain bark beetles at static levels.

COOPER LAKE ROAD:

Stand Composition: The Cooper Lake Road stand is characterized by relatively steep terrain. The majority of the trees on the plots are hemlock (63%), white spruce (35%) and birch comprising the remainder. Mean diameters for the species are: white spruce 19.1 ± 5", hemlock 11.8 ± 4.9", and birch 15.9". Mean height and age for white spruce are 74.9 ± 19.3' (n=13) and 120.4 ± 41.3 years (n=9), respectively.

Mean basal area for plots containig spruce is 27.8 ± 6 square feet per acre. The mean outer inch of spruce radial growth is 25.1 ± 11.9 rings per inch. Thus, spruce diameter growth is averaging .08 inches per year in the last inch of growth. Mean commercial spruce volume on those plots containing spruce is 3,225 b.f. per acre.

Spruce Beetle Populations and Tree Mortality: Twently bark samples (60% infested) were removed; a total of 76 adult beetles were counted indicating a static population (Knight 1960). Few signs of woodpecker activity were observed in the area. Little beetle activity was noted in the stand composition plots: no new attacks or standing beetle killed trees were observed.

The bark beetle activity in this area is scattered, encompassing 3,000 acres. This infestation is not causing much damage in the evaluated area as mean basal area for plots containing spruce is only 27 square feet. A small spruce component helps keep the beetles in check. The spruce are widely spaced and thrifty (e.g. "resistent" to spruce beetle depredation).

SUMMIT LAKE:

Stand Composition: Bottomland sites are wet and characterized by white spruce, cottonwood (Populus trichocarpa Torr.&Gray) and willow (Salix spp.). Hemlock is encountered on the hillsides. Mean diameters for the species are: spruce 12.1 ± 4.6 ", cottonwood 13.8 ± 4.1" and, hemlock 7 ± 2.4". Most of the spruce are between 80 and 120 years old (Averill 1978).

Mean basal area for plots containing spruce is 87 ± 51 square feet per acre, ranging from 20 to 200 square feet. The mean outer inch of radial growth is 24 ± 10 rings per inch. Thus, diameter growth is .08 inches per year in the last inch of growth (Averill 1978).

Spruce Beetle Populations and Tree Mortality: Twenty bark samples (95% infested) were removed yielding a total of 389 adult beetles indicating an increasing population (Knight 1960). Mean adult density per sample was 19.5 ± 17.4 beetles. The 1980 beetle densities are significantly higher than those reported in 1978 (Averill) and 1979 (Holsten and Zogas). Mean diameter of infested trees in 1978 (Averill) was 14.4 ± 4.7".

A demonstration project aimed at reducing Summit Lake spruce beetle populations through silvicultural manipulations should be completed during the Winter of 1980-81. Should this demonstration prove successful in reducing beetle attack within the treated area, additional treatments should be considered after 1981 beetle flight. Silvicultural manipulations should not only reduce the insect threat but could also serve to enhance a multiple of management objectives in these high valued roadside areas.

SILVERTIP CREEK:

Stand Composition: The plots were comprised of spruce (95%) with some scattered birch (3%) and hemlock (2%). Pockets of old blowdown occurred throughout the study site. Mean diameters of the species are: white spruce 13.4 ± 4.8 (n=101), birch 6.7 ± 1" (n=3) and, hemlock 5.7 ± 1.6" (n=2). Mean height and age for spruce are 63.1 ± 17.3" (n=41) and 139.8 ± 35.8 years (n=19), respectively.

Mean basal area for plots containing spruce is 101 ± 14.2 square feet per acre, ranging from 20 to 180 square feet. The mean outer inch is spruce radial growth is 34.3 ± 17.4 rings per inch; spruce diameter growth is averaging .06 inches per year in the last inch of growth. Mean volume for plots containing spruce is 7,452 b.f. per acre.

Spruce Beetle Populations and Tree Mortality: Twenty bark samples (70% infested) were removed and yielded a total of 174 adult beetles indicating an

increasing population (Knight 1960). Mean adult density per sample was 8.7 ± 12 beetles. Some woodborer (cerambycid) competition was noted in the bark samples.

Mean diameters of recently attacked and old attacked (dead) white spruce are 15.7 ± 4.8" and 14.2 ± 4.7", respectively (not sign. diff.). Standing beetle killed timber and newly attack spruce comprise 10 percent (719 b.f./ac.) and 17 percent (1,274 b.f./ac.), respectively. The majority of the newly attacked spruce will die. Seventy-three percent of the commercial white spruce is free of attack.

The 200 acre Silvertip infestation is from two to three years old. It is relatively young and increasing as mean diameters of recently attacked trees (15.7") are significantly higher than mean spruce diameters (13.4") in the evaluated area. As beetle activity has been prevalent in the surrounding area (Holsten and Zogas 1979), beetles immigrating from nearby infestations, such as Dry Gulch, probably initiated the Silvertip infestation.

Assuming that the newly attacked spruce will die, bark beetles have killed $7,972 worth of commercial spruce throughout the 200 acre infestation. Since this infestation is increasing, we can expect at least $3,000 worth of spruce killed each year if the infestation is allowed to run its natural course.

SKILAK LAKE CAMPGROUNDS (KENAI NATIONAL MOOSE RANGE):

Stand Composition:

Lower Campground: The stand which was evaluated was comprised mainly of white spruce (93%) with some birch (7%). The understory contained alder and grass. No blowdown was observed. Mean diameter of the spruce was 8 ± 1.8" and that of birch was 6.3 ± 1.2". Mean age and height of the white spruce were 171.8 ± 44.7 years (n=20) and 41.9 ± 4.6' (n=8), respectively.

Mean basal area for plots containing spruce was 100 ± 34.6 square feet per acre, ranging from 40 to 200 square feet. The mean outer inch ofspruce radial growth is 33 ± 10 rings per inch. Thus, diameter growth is averaging .06 inches per year in the last inch of growth. Mean volume for plots containing white spruce is 4,656 b.f. per acre.

Upper Camground: The stands evaluated in the upper camground are similar in composition to those in the lower camground. Mean diameter of the spruce is 12.5 ± 3.1" (n=100). Mean spruce age and height are 181 ± 52 years (n=8) and 67 ± 11' (n=42), respectively.

Mean spruce basal area is 100 ± 40 square feet per acre, ranging from 40 to 180 square feet. The mean outer inch of spruce radial growth is 41.6 ± 21 rings. Diameter growth is .05 inches per year. Mean volume for plots containing spruce is 8,039 b.f. per acre.

Spruce Beetle Populations and Tree Mortality:

Lower Campground: Twenty bark samples were removed yielding a total of six beetles indicating a decreasing population. Heavy woodpecker feeding was prevalent in the area. Average diameters of newly attacked and old attacked trees are 8.5 ± .6" and 9.2 ± 2", respectively. Four percent (175 b.f./ac.) of the commercial volume is in standing beetle killed timber. Another one percent (61 b.f./ac.) is newly attacked.

Upper Campground: Eighty-six beetles were counted from twenty bark samples indicating a static population (Knight 1960). Woodpecker activity was apparent throughout the study site. Average diameter of old attacked, dead trees (14 ± 2.5") was significantly larger (Students "T", .05) than diameters of newly attacked spruce (12.4 ± 2.7"). The majority of the commercial volume (64%, 4,011 b.f./ac.) has been killed by spruce beetles. Another 16 percent (1,202 b.f./ac.) of the commercial volume is attacked and may die.

A potential total loss of $3,304 worth of commercial spruce can be expected in and around the lower campground. However, future losses will decline as beetle populations decline. Average diameter of recently attacked trees is 8.5". Spruce beetle brood production and development decreases when the diameter of attacked trees approaches 8" or less.

On the other hand, spruce beetle populations are static in the upper campground area (300 acre infestation). Total monetary loss of commercial spruce in this area ammounts to $31,278. Since the population is static, an equal number of trees will be attacked in 1981; amounting to a loss of approximately $7,212 per year. However, this outbreak is not new as mean diameters of newly attacked trees are significantly less than old attacked trees. Thus, the beetles will be "forced" to attack smaller diameter trees in the future leading to a decline in beetle populations within a few years.

However, the "real loss" is not stumpage, but reduced or altered recreation values. Although tangent values for recreation are difficult to determine, we can assume that the "recreation loss" in dollars is higher than the stumpage loss since these areas were selected for campgrounds vs. timber production. Even though bark beetle populations will decline, resulting in decreasing stumpage losses, the "loss" in recreation will remain constant as the "damage" has been done.

MANAGEMENT ALTERNATIVES

MAINTAIN PRESENT MANAGEMENT--The spruce beetle infestations would be allowed to run their course under this approach. The beetle would dictate managament outputs from the infested areas and would tend to constrain the management directions that could be taken in these areas (Averill 1978). If left alone, spruce beetle infestations would collapse from a combination of:(1)lack of large diameter trees to maintain brood production; (2)unfavorable weather conditions, especially during adult Spring dispersal; and (3)heavy predation and parasitism. However, adverse as well as beneficial effects of the outbreak would have to be accepted, such as:

(1)Changes in the forest plant composition could occur as a result of the opening of the forest canopy. Such changes may result in reduced spruce regeneration if no site disturbances occur. Reforestation may be necessary. However, some of the plant composition changes may be beneficial to some wildlife.

(2)Following spruce beetle infestations, fire risk may increase. There will be an increase in rate of spread, ignition probability and burning index.

(3)Visual qualities and social impacts would result if this alternative was

selected (Averill et. al 1977). The ratio of green spruce to "red topped" spruce to gray snags will increase toward the snag end of the scale if spruce beetle populations continue to increase. The introduction of color or variety may be unacceptable due to the psychological impact of introducing dying plant materials (Averill et. al 1977). In addition, the dead trees will constitute a safety hazard to visitors using the areas.

(4)There will be no direct costs associated with selection of this alternative although as previously mentioned, timber values will be affected and revenues reduced when severly damaged stands are harvested. Likewise, this alternative would not be effective in preventing additional tree mortality.

Table 1 displays the potential loss of these infestation centers. Assuming that the volume were available to the market at $20 MBF, the present value of the anticipated loss is $260,413.34. The lands evaluated are not designated for commercial timber production but are managed for their recreational and wildlife values. One must assume that the total value of these lands is greater than what is being lost now. Management must ask themselves what outputs are or will be threatened by large spruce beetle outbreaks in the Cook Inlet area. Where loss levels exceed management goals then action must be taken to prevent the loss. Management needs to be very much aware of the potential adverse public reaction to excessive tree mortality. As more visitors and residents become aware of the spruce beetle and what is happening, one may anticipate a demand to control or at least manage the beetle populations at an acceptable level.

CHEMICAL SUPPRESSION--The use of registered pesticides for spruce beetle prevention and suppression is a viable alternative in certain situations:

(1)On a large scale, use of pesticides is not economically practical as applications must be done on the ground to every infested tree.

(2)However, in recreation areas and campgrounds where tree mortality would be unnacceptable and hazardous to visitors, individual high value trees could be treated with an EPA-registered insecticide. Application costs would have to be accepted. Adverse environmental effects would be minimal and temporary.

A registered insecticide for use against the spruce beetle is Lindane^{R}.

TRAP TREES--This alternative involves the falling of green uninfested trees to serve as an attractant to flying adults. Removal and treatment of the infested trees would occur after flight is complete.

Effects of this treatment are:

(1)This method has been used on the Chugach National Forest with success and is a viable alternative.

(2)Trees must be felled before beetle flight. Removal of infested felled trees is necessary within one year of infestation. If they are not removed, beetle populations will dramatically increase in the already infested area.

TABLE 1. Potential Loss (B.F./Infestation)[1/]

	BEETLE POPULATIONS[2/] Inc.	Static	Dec.	1980	1981	1982	1983	1984	1985
Russian River	---	---	X	105,500	105,500	105,500	0	0	0
Snug Harbor	---	X	---	1,792,624	1,792,624	1,792,624	1,792,624	0	0
Cooper Lk. Road	---	X	---	0	0	0	0	0	0
Summit Lk.	X	---	---	[3/]	[3/]	[3/]	[3/]	[3/]	[3/]
Silvertip Creek	X	---	---	254,800	254,800	254,800	254,800	254,800	254,800
Skilak Lk. Lower	---	---	X	122,500	122,500	122,500	0	0	0
Skilak Lk. Upper	---	X	---	1,203,300	1,203,300	1,203,300	1,203,300	0	0
Total B.F.				3,478,724	3,478,724	3,478,724	3,250,724	254,800	254,800
Stumpage ($20/MBF)				$69,574.48	$69,574.48	$69,574.48	$65,014.48	$5,096.00	$5,096.00
4% inc. Stumpage				$69,574.48	$72,357.46	$75,244.80	$73,141.29	$5,962.32	$6,199.28
NPV[4/] of Pot. Loss				$69,574.48	$65,779.44	$62,186.06	$54,951.78	$4,072.32	$3,849.26

1/ Volume lost in timber killed prior to 1980 is not included.
2/ Assuming increasing, static, and decreasing populations will continue for 5, 3, and 2 years, respectively.
3/ No sufficient data.
4/ Net Present Value using a 10% Discount Rate.

SALVAGE LOGGING--Logging of infested material would remove the material to another location where the brood could be destroyed.

Effects of this alternative are:

(1)The lumber from the infested trees could be utilized.

(2)However, the removal of the infested trees may only be a temporary solution. Stand composition would not be altered to any degree through salvage logging alone. Thus, risk of future infestations will remain high.

FELLING AND BURNING OF THE INFESTED TREES--Falling and burning infested trees will destroy bark beetle brood.

Effects of this alternative are:

(1)This should be done in Winter to reduce fire hazards and to kill beetles before Spring emergence.

(2)Lumber from the infested trees is not utilized.

(3)This alternative may not prevent future infestations occurring in the treated area.

SILVICULTURAL MANAGEMENT--Silvicultural treatments in white spruce stands should be designed to create stand conditions that minimize tree mortality. Thinning of the residual stand and removal of the currently infested trees eliminates the immediate threat, as well as creating a "beetle proof" stand for the next 20 or more years. This method appears to work with other Dendroctonus beetles and should work with spruce beetles (Averill 1978).

Effects of this alternative are:

(1)Conversion of spruce stands to a less susceptible state could be costly; however, long term benefits could be achieved. A sale for the removal of infested material as well as thinning could be let, thereby lowering the cost of this alternative.

(2)Thinning of overstocked groups of trees to basal areas of 80-90 square feet per acre improves tree growth in terms of diameter, volume and height through reduced competition. Stands with healthy, vigorous-growing trees are more resistent to losses by the spruce beetle than slow-growing or stagnant stands.

(3)This alternative would maximize investment returns since other management alternatives do not treat the mid-range (5-20 yr.) risk (Averill 1978).

(4)Application of sound silvicultural treatments would enhance other management objectives identified by the Forest.

RECOMMENDATIONS

Forest Pest Management would like to see the continuation of silvicultural manipulations in the Summit Lake area to show that regulating stand density not only minimizes spruce beetle threat, but can be used to enhance a multiple of management objectives in high valued roadside areas.

Potential losses from the spruce beetle can be minimized through an accelerated program of: (1) logging or burning of infested trees, and (2) silvicultural treatments. This treatment should be directed to those stands rated medium and high risk as to susceptibility of beetle attack (Holsten and Wolfe 1979, Holsten 1979). Recurring epidemics can be expected on the Kenai Peninsula until average tree diameter of the stand is reduced to approximately 8-10" and basal area reduced to approximately 80 square feet per acre.

High valued recreation and administrative sites, such as Tenderfoot Campground and the Kenai Lake Work Center, could be treated with the protective chemical Lindane^{R} to prevent spruce beetle attack. This should be carried out until the surrounding epidemics subside.

****

Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife - if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers. Mention of a pesticide in this publication does not constitute a recommendation for use by the USDA, nor does it imply registration of a product under the Federal Insecticide, Fungicide, and Rodenticide Act, as ammended. Mention of a proprietary product does not constitute an endorsement by the USDA.

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APPENDIX A

STAND STRUCTURE

	STAND COMPOSITION(%) SPRUCE	BIRCH	HEMLOCK	SPRUCE DBH(in.)	SPRUCE HT(ft.)	SPRUCE AGE(yr)	AV.DIA. GROWTH (in./yr.)	SPRUCE B.A. sqft/ac	SPRUCE VOLUME b.f./ac
Russian River	84.3	2	13.3	12.4	86.6	209	.05	138	15,594
Snug Harbor	91	5	9.8	11.4	65.5	193	.05	101	6,578
Cooper Lk. Road	35	2	63	19.1	74.9	120	.08	28	3,225
Summit Lk.	---	---	---	12.1	---	100	.08	87	---
Silvertip Creek	95	3	2	13.4	63	140	.06	101	7,452
Skilak Lk. Lower	93	7	0	8	42	171	.06	100	4,656
Skilak Lk. Upper	93	7	0	12.5	67	181	.05	100	8,039

APPENDIX B

SPRUCE BEETLE POPULATION AND TREE MORTALITY

	Beetle Population			D.B.H. new attacks (in.)	D.B.H. old attacks (in.)	Vol. Lost in beetle kill(/ac.)A	Vol. in new attacks (/ac)B	Total Poss. volume loss (/ac.)A + B
	Incr.	Static	Decr.					
Russian River	---	--	X	14.6	13.6	1,055(7%)	1,553(10%)	2,608(17%)
Snug Harbor	---	X	---	12.1	12.4	2,311(35%)	2,476(38%)	4,787(73%)
Cooper Lk. Road	---	X	---	----	----	----------	----------	----------
Summit Lk.	X	---	---	14.4	----------	----------	----------	----------
Silvertip Creek	X	---	---	15.7	14.2	719(10%)	1,274(17%)	1,993(27%)
Skilak Lk. Lower	---	---	X	8.5	9.2	175(4%)	61(1%)	236(5%)
Skilak Lk. Upper	---	X	---	12.4*	14.0*	4,011(64%)	1,202(16%)	5,213(80%)

* sign. differance, Students "T", .05

APPENDIX C

IMPACT

	Acres Infest.	Actual loss ($) per ac.(A)	Actual loss ($) (B)	Potential loss ($) per ac.(C)	Potential loss ($) (D)	Total loss ($) per ac.(A+C)	Total loss ($) (B+D)
Russian River	100	21.10	2,110	31.06	3,106	52.16	5,216
Snug Harbor	724	46.22	33,463.28	49.52	35,852.48	95.74	69,315.76
Cooper Lk. Road	3,000	-----	-------	-----	-------	-----	------
Summit Lk.	13,546	*	*	*	*	*	*
Silvertip Creek	200	14.38	2,876	25.48	5,096	39.86	7,972
Skilak Lk. Lower	700	3.50	2,450	1.22	854	4.72	3,304
Skilak Lk. Upper	300	80.22	24,066	24.04	7,212	104.26	31,278

* No sufficient data

APPENDIX D

SPRUCE BEETLE

COLEOPTERA:SCOLYTIDAE

Dendroctonus rufipennis (Kby.)

HOST--White, Sitka, and rarely black spruce

DAMAGE--Larvae feed under tree bark which may result in tree death

DISTRIBUTION--Throughout Alaska where host is located. A serious forest pest especially in south-central Alaska.

DESCRIPTION--Adult spruce beetles are dark brown to black, cylindrical in shape, approximately 5mm long and 3mm wide. The larvae are stout, white, legless grubs, 6mm long at maturity. The pupae are white, soft-bodied, and adult shaped.

BIOLOGY--The life cycle of the spruce beetle in Alaska is not definitely known, but is believed to be two years in duration. Adult and larval activity begins in May when under the bark daytime temperatures reach about 8°C(47°F). Recently emerged adult beetles disperse in search of susceptible host material during late May and early June when daytime ambient temperatures are at least 16°C(61°F). Dispersing adults adults can fly long distances, over seven miles nonstop. Adult mortality during dispersal may exceed 50 percent. Females are attracted to windthrow and other large diameter (8" or more) down material and begin the attack; males arrive later.

Beetles prefer to begin attack on the sides and bottoms of downed material. Under such conditions, temperature and moisture regimes are favorable for brood development and survival. Unpublished data indicate that windthrown trees can remain attractive through two attack periods. Males and other females are attracted via sex and aggregating pheromones. D. rufipennis is monogamous, and females deposit eggs in niches along the sides of the vertical egg gallery in a standing tree. Egg galleries, except for the terminal portion, are packed with frass and boring material. Most eggs hatch by August.

Larvae predominate during the first overwintering period, although other life stages may be present. Most of the larvae pupate in the following summer; the pupal period last 10-15 days. The adults may overwinter in their pupal sites or migrate to the base of infested trees. This migration is an adjustment to cold temperature survival. The following spring (approximately two years after attack) adults emerge and attack new host material. In general, females only attack once.

Most D. rufipennis outbreaks in standing timber have originated in blowdowns although logging residuals (cull logs) may be a contributing factor. In the Rocky Mountains and probably Alaska, the susceptibility of standing spruce decreases in the following order: (1)Large diameter trees along creek bottoms, (2)Better stands on benches, (3)Poorer stands on ridges and benches, (4)Mixtures of spruce and other species, and (5)Stands of immature trees.

In the lower 48 states, parasites and predators help reduce and maintain spruce beetle populations at low levels. However, the effect of predation and parasitism on spruce beetle populations in Alaska is not known. In the Rocky Mountains, Northern 3-toed, hairy, and downy woodpeckers can consume 40-98 percent of beetle brood during outbreak conditions. These predators are common in Alaska in beetle infested areas and probably contribute to the decline of epidemic insect populations. Low temperatures are effective controls if the cold spells occur early before the insects become cold hardy.

REFERENCES

Averill, R.D., Gunter, J.E., Lister,C.K., and D.H. Sonnen. 1977. Guidelines for Estimating the Economic Benefits of Mountain Pine Beetle Control Projects. Tech. Rpt. R-2-11, For. Ins. and Dis. Mgt., USDA For. Serv., Rocky Mtn. Region. 30p.

_____. 1978. Spruce Beetle--Summit Lake. Biol. Eval. R-10-78-3. For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 8p.

Holsten, E.H., and R.L. Wolfe. 1979. Spruce Beetle Risk Rating System for White Spruce on the Kenai Peninsula. Tech. Rpt. R-10-1, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 21p.

_____. 1979. Supplement: Spruce Beetle Risk Rating for White Spruce on the Kenai Peninsula, Tech. Rpt. R-10-3, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 10p.

_____, and K.P. Zogas. 1979. Spruce Beetle--Summit Lake, Dry Gulch, Cooper Landing. Biol. Eval. R-10-79-4, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 18p.

Knight, F.B. 1960. Sequential sampling of Englemann spruce beetle infestations in standing trees. USDA For. Serv., Rocky Mountain For. and Range Exp. Stat., Res. Note 47. 4p.